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DIMENSIONS/NBS

WHAT MADE THE HATTER MAD?

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COVER: The Hatter's curse, mercury poisoning, is still a threat in some occupations. The story beginning on the opposite page examines a sensitive new mercury "monitor" for people who work with the metal.

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Center for Radiation Research
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NBS DEVELOPS NEW MERCURY MONITOR

Aids in Fight Against Industrial Mercury Poisoning

by Madeleine Jacobs
NBS public information specialist

REMEMBER the Mad Hatter—the funny looking man with the big hat in *Alice in Wonderland* who was always asking crazy riddles and talking nonsense? People today think of the Mad Hatter as a memorable character in a story, but to people in the 1800's he was an unpleasant reminder of the times—a victim of mercury poisoning. In fact, until recently hatters actually did go mad. The mercury compound used in curing felt and fur for hats was a common cause of mercury poisoning well into this century. Victims developed a tremor called "hatter's shakes," which affected their eyes and limbs and addled their speech. In advanced stages they developed hallucinations and other psychotic symptoms.

Although the use of mercury in the hat industry was outlawed in the 1940's mercury poisoning is still an occupational hazard today. The "metal of a thousand uses," as mercury has been called, is a prime component in the electrical apparatus industry, such as in the manufacture of dry cell batteries, switches, and other electrical components. Its single largest use is in the production of two industrially important chemicals, chlorine and caustic soda. Because of its versatile and unique properties, mercury and its compounds are also used widely in pharmacology, the paint industry, agriculture, and a myriad of other applications. Today, nearly 150,000 workers are routinely exposed to mercury on the job.

Mercury Standards

To protect these workers, the National Institute of Occupational Safety and Health (NIOSH) several

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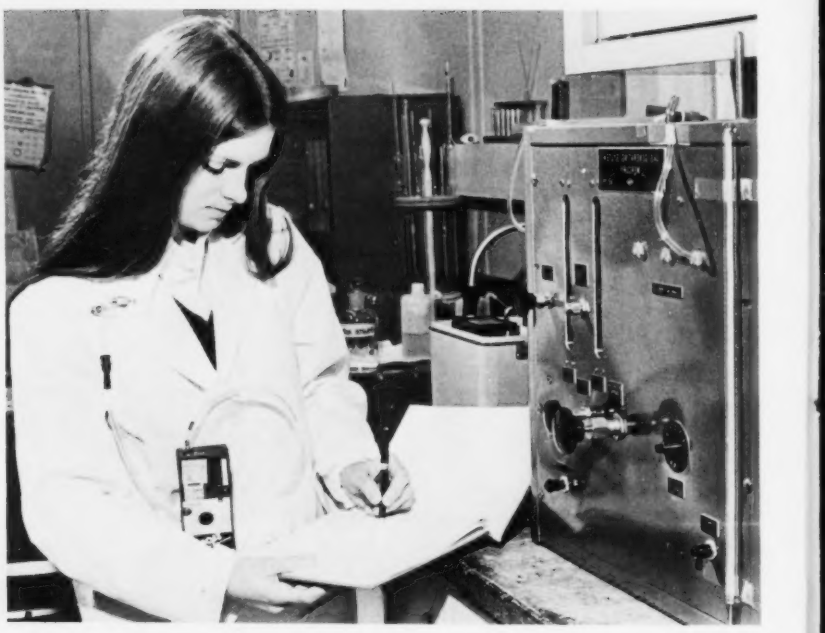

The mercury monitor at work. The sensing device of the monitor is worn on the lapel of a lab coat or shirt in the "breathing zone" of the worker. The miniature air pump attached to the sensor is worn in a pocket or around the worker's waist.

MERCURY *continued*

years ago formulated standards which limit the exposure of workers to mercury. The standard is designed to protect the health and safety of workers for an 8-hour day, 40-hour week over a working lifetime. According to the standard, workers are not to be exposed to concentrations of mercury greater than 0.05 milligrams per cubic meter determined as a time-weighted average exposure for an 8-hour workday. Employers are required to take steps to insure that the standard is met. This usually involves monitoring environmental levels of mercury in the "breathing zones" of workers, since most mercury poisoning is caused by inhalation of mercury vapors.

To assist in this monitoring, two scientists at the National Bureau of Standards have developed a new mercury monitor which will help public health officials determine if a worker has been unduly exposed to mercury. In addition to its extreme sensitivity and selectivity for mercury, the monitor is portable, easy and inexpensive to produce, and reusable. And, unlike other monitors currently in use, the NBS device gives the total accumulated dosage of mercury over a workday—called for by the NIOSH standard—rather than the concentration of mercury a worker is exposed to at a given time.

In developing the mercury monitor, or "dosimeter," Dr. Eugene P. Scheide and Dr. John K. Taylor, chemists in the NBS Institute for Materials Research, employed several well known principles. In effect, the monitor is a "microbalance," according to Scheide, whose research was supported by the NBS Office of Air and Water Measurement.

New Monitor

The key to the microbalance is a quartz crystal which vibrates at a certain, known frequency. This is called a piezoelectric crystal detector. Knowing that gold selectively adsorbs and amalgamates mercury, Scheide and Taylor evaporated a thin layer of gold onto the crystal. Mercury vapor present in the workplace atmosphere is adsorbed by the gold. A mathematical formula developed by another scientist in 1959 relates the change in frequency of the crystal to the mass of mercury adsorbed. The amount of mercury adsorbed by the gold over a day is determined by measuring the change in frequency of the crystal. After the frequency change is measured, the monitor can be restored for reuse by placing it in an oven at 150° C and passing clean hot air over the monitor. Using this method, more than 90 percent of the adsorbed mercury is removed.

One of the most significant features of the NBS device is its portability. Many mercury monitors in use today are stationary and so do not necessarily measure accurately the worker's real exposure to mercury. This is because the concentrations of mercury in the work site vary from place to place in a room and even around the vicinity of a worker. The NBS dosimeter, on the other hand, is small and light—about 2 x 2 x 5 cm in size and 10 g in weight. The crystal itself is enclosed in a glass holder and is sealed to it at the base using epoxy cement. A restriction in the entrance of the holder focuses the air stream to about 2 mm diameter at

the center of the crystal. In the workplace the dosimeter would be worn on a worker's clothing in his breathing zone and would be used in conjunction with commercially available miniature air pumps (about 3 x 6 x 13 cm in size and 200 g in weight). At the end of the workday, the dosimeter is sent to a central lab where the change in frequency of the crystal is measured and the amount of mercury the worker has been exposed to is calculated. The dosimeter does not read out directly.

Another key feature of the mercury monitor is its extreme sensitivity and selectivity for mercury. In fact, the monitor is much more sensitive than most other techniques that are now employed, with an ability to measure mercury concentration levels at the parts-per-billion level. In addition, other pollutants which might be present in a workplace, such as sulfur dioxide or nitrogen dioxide, do not interfere with the monitor's readings of mercury. Scheide adds that the monitor is easily stored and can be reused at least 100 times without ill effects.

Other Applications

The main drawback of the monitor at the present time is that each device must be calibrated individually. However, the cost of an individual mercury analysis using the piezoelectric sensor is relatively low since the sensor can be reused many times and the frequency measurement and data processing can be automated. The analytical instrumentation needed to read the frequency changes in the crystal is also relatively inexpensive compared to other equipment currently in use for mercury monitoring.

Scheide points out that although the dosimeter was developed for monitoring mercury in the industrial workplace, it has other possible uses in long term studies of mercury exposure. For example, it might be useful for dentists and dental hygienists who have long term exposure to extremely small concentrations of mercury. In addition, the principles employed in the dosimeter—the piezoelectric crystal detector and selective coating—might well be applicable to the measurement of other important pollutants. □

The key to the mercury monitor—a quartz crystal which vibrates at a certain known frequency. The piezoelectric crystal, coated with a thin layer of gold to adsorb mercury present in the workplace, is enclosed in a glass holder.

An EPIC Undertaking:

OUT OF THE CLASSROOM, INTO THE PLANT

A gas utility, a steel plant, an industrial research and development laboratory, and a government hospital are no less immune than the rest of us to the need for energy or to the effects of rising energy prices and fuel shortages. But they also share the need to reduce energy use without disrupting productivity and vital services.

For the past year and a half these and a number of other organizations in the Pittsburgh area have been receiving some practical advice on energy management from University of Pittsburgh students taking part in a unique course on energy conservation. One of the main resources for the course is the EPIC handbook, developed and published by the National Bureau of Standards and the Federal Energy Administration (see box). As a result of the Pittsburgh success, plans are underway at NBS, the Department of Commerce, and FEA to expand the use of EPIC in university courses elsewhere in the country.

As often as possible, Margaret Carson, Environmental Coordinator for Gulf Trading and Transportation Company, visits the Allegheny County Sanitary Authority (ALCOSAN) in Pennsylvania. Her mission: Offer new insights and advice for saving energy. Carson isn't moonlighting, however. She's taking part in a course on energy management for industry and commerce at the University of Pittsburgh.

The course, which has been offered for the past year and a half in the School of Continuing Education and the School of Engineering, was developed by mechanical engineering professors Wesley Rohrer and William Rudoy. "The main goal of the course," Rohrer says, "is to educate the students, many of whom are practicing engineers, and companies in the practical aspects of managing an energy conservation program." In the course of achieving this goal, Rohrer and Rudoy have also evaluated, through the students' experiences, the usefulness of the EPIC handbook in implementing an energy conservation program and have made recommendations for the best means of using it. The evaluation has been supported by the NBS Office of Energy Conservation, Center for Building Technology, and the FEA Office of Energy Conservation and Environment.

Theory and Practice

The course is a blend of the theoretical and practical, combining classroom lectures on such topics as thermodynamics, heating, ventilating, and air conditioning systems, energy auditing, and economics, with a practical field test of the principles and guidelines provided in the lectures and the EPIC handbook.

In carrying out a field project, each student assumes the role of an energy conservation coordinator for an industrial plant or department of a plant or other organization. In each case, the project is planned ahead of time by the University of Pittsburgh faculty and company management, and the company assigns someone to maintain liaison with the student and faculty.

A student is expected to help the management of his assigned company set up an appropriate energy conservation program and initiate its implementation. The student carries out plant surveys and systems analyses of energy use, makes periodic reports to management on possible energy conservation opportunities and the energy savings expected from them, the capital costs involved and their investment merit (benefit-cost ratio), and documents the whole project by way of a term report. The course consists of 14 weekly 2½ hour lecture-recitation periods. Students are also expected to spend at least half a day each week at their assigned plant or company. In addition to topics covered during lecture periods, at least 1 hour each week is taken up with class discussions of project development, especially current problems, and success and failure experiences.

To date, about 80 students have completed the course. Students come from diverse backgrounds and have different motives for taking the course. In some cases the students are practicing engineers responsible for energy management in their firms, and they are primarily interested in improving energy use in their own organization. Many of these students are assigned their own firms as field projects. In other cases, students are employed in related areas where energy management plays a key role. Some of these students, such as Margaret Carson, are studying for a master's degree in Energy Resources.

Success Stories

Rohrer admits that not everybody has had equal success with their assigned company or with use of the EPIC handbook. This is due not only to the varying attitudes of management toward energy conservation but also to the fact that 14 weeks is a short time in which to make major changes in the operations of an organization. Some students have had remarkable success and nearly all students have had high praise for the course and the EPIC handbook.

Most students agree with Carson who comments that the EPIC handbook reflects ". . . thousands of hours of groundwork and valuable ideas for saving energy. The course also reflects the way energy problems are going to be solved in the future—by examining the trade-offs between the different kinds of fuels that can be used and studying the merits of using one versus another."

Carson points out that the course stresses the need to look at the question of energy consumption per unit of process, especially in the type of organization she is studying for the course—a sewage treatment facility. She also likes the fact that the course

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University of Pittsburgh students learn how to establish an energy conservation program from the EPIC handbook in classes conducted by Professor Wesley Rohrer, then go out into the field and apply what they've learned in an actual plant situation.

brings together people with diverse backgrounds from different industries so they can share experiences and learn from each other's successes and failures.

Donald Clayton, another student who took the course, comments that the project "really hit home," especially with natural gas curtailments in the Pittsburgh area. As energy coordinator for the Bridgeville plant of the Specialty Steel Division of Cyclops Corporation, Clayton first looked at the obvious sources of energy waste in his plant, such as eliminating leaks. "I was trained as a metallurgist," Clayton explains, "so the course offered a lot of new ideas. Now we are looking at a lot of other sophisticated changes in equipment and operations, some of which we expect will save us a lot of energy."

Another student, Stanley Kletch, was also assigned his plant as his field project. Kletch, energy engineer for Jones and Laughlin Steel Corporation in Aliquippa, Pa., praised the general nature of the course and the EPIC book. "When you're looking for innovations in saving energy, it's best to have a good grounding in general principles," he says. "That usually leads to new ideas faster than specialized knowledge of a discipline."

In summarizing his experience with the course, Rohrer notes some obvious accomplishments:

- Eighty engineers and managers have received basic training in industrial energy management and have become familiar with the virtues of the EPIC handbook.
- As a result, a number of energy management programs have been implemented in both large and small industrial and commercial units in the Pittsburgh area. A modest beginning has also been made in stimulating natural gas conservation in the Pittsburgh area, which faces very serious fuel allocation cutbacks.
- The base studies generated during the field projects have yielded a wealth of information on the efficacy of the EPIC program.

"In effect," says Rohrer, "the course has shown that the EPIC program is useful to both large and small industrial units in setting up energy management programs. In particular, the course proved that the EPIC program is applicable and transferable to the public service sector of the economy —an area that has been neglected in energy conservation."

New Emphasis

Since the energy course was first offered at Pittsburgh, several topics have received greater emphasis, Rohrer adds. "In general, we have found that energy management programs suffer from a lack of firm data on energy usage within individual plants, departments, or product lines," he says. "Industrial management is not accustomed to using energy cost data as a management decision tool. It is necessary for industrial management to audit their energy usage to include the data in making management decisions. It cannot be emphasized too strongly that energy audit implies metering, data storage and recovery, and use of energy data in management decision making. In this course, we are trying to educate industrial management to use energy accounting in the same way it uses financial information."

Vital Resources

Rohrer also emphasizes that the course points up that the EPIC handbook is most useful to industrial or commercial units if it is introduced to management by a qualified expert who can educate employees in its use. Students in graduate and continuing education courses, such as the one at Pittsburgh, can serve as experts for this purpose, he believes. The expansion of courses such as this one to other universities across the United States would therefore serve a double purpose: It would not only educate students who are planning to become managers or are now managers in energy conservation, but would serve as a vital resource to smaller and medium sized industries who need a good deal of technical help to initiate and maintain an energy conservation program, but cannot always afford to hire an outside consultant.

The student experiences with the course and with EPIC have been documented by Rohrer and Rudoy in a report to the NBS Office of Energy Conservation. OEC's Robert Massey, EPIC project leader and an author of the original EPIC handbook, says "Our intention is to publish the report, which also contains a class syllabus and classroom lecture notes, and make it available to other colleges and universities interested in teaching energy management courses."

"When EPIC was first published," Massey recalls, "it received rave reviews, but few people knew how the handbook would actually be used in practice. I think we can agree now that the experience at the University of Pittsburgh and elsewhere confirms the assessment of one of the reviewers who said, 'EPIC represents the most practical and down-to-earth document on energy conservation which I have seen.' "—*M.J.* □

EPIC Success Story

The Energy Conservation Program Guide for Industry and Commerce (EPIC) is one of the many tools provided by the Department of Commerce and the Federal Energy Administration to assist commerce and industry in their efforts to use energy supplies more efficiently.

Prepared by the National Bureau of Standards and the Federal Energy Administration (FEA), EPIC outlines in detail the steps in setting up an energy conservation program and suggests specific Energy Conservation Opportunities (ECO's). ECO's are a key part of the handbook. More than 200 ECO's are suggested. ECO's are one-sentence tips suggesting specific ways to conserve energy in 13 functional and operating areas, such as commercial practice, electric power, process changes, and materials handling.

The checklists of ECO's are supported and referenced by actual case histories illustrating how energy savings have already been achieved in many organizations. Illustrations are based on specific industrial and commercial experiences or are representative of several experiences. In addition to a brief description of the action taken to achieve energy savings, the reports include graphs, tables, and sample calculations from which a company can estimate its potential for saving energy and reducing costs.

Other sections of EPIC provide supporting information which would be useful in a conservation program. Sections are devoted to data and conversion factors pertinent to energy conservation, financia analysis procedures for evaluating projects, sources and organizations to contact for information on energy conservation, possible safety, health, and pollution considerations that may impact on conservation measures, techniques for developing employee participation in an energy conservation program, a brief guide to the existing technology and instruments for measuring energy-related flows, and a bibliography of energy conservation articles.

The first supplement of EPIC provides more ideas and suggestions from successful programs. It contains a reorganized and simplified explanation of how to implement an energy conservation program, it expands the checklist of ECO's, it includes 2 dozen additional case studies, and it adds information such as the applicable regulations of the Occupational, Safety and Health Administration. Much of the material in the supplement is the result of enthusiastic comments and suggestions from the purchasers of the first 40,000 copies of EPIC. The use of the handbook as basic material for a number of State energy conservation workshops has also supplied important information.

EPIC and the supplement are intended to be used together. Both are available as pre-punched, three ring books that can be collated in a three ring binder. EPIC and the EPIC supplement may be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. Order EPIC by S.D. catalog number C13.11:115 at $2.90. Order the supplement by S.D. catalog number C13.11: 115/1.

Metal Fires-Science and Safety

*by John L. Moulder**

A Fourth of July fireworks display. A meteor shower. A flashbulb. A rocket engine. What do these things have in common? They all involve the burning of metal—something we normally think of as indestructible by fire. Yet under certain conditions, metals will burn—all of them except gold and silver—and they usually burn with destructive force, generating large amounts of heat and light.

Meteors, which are largely composed of metals such as iron and nickel, heat up and burn as they enter the earth's atmosphere. As we all know, the surface of the earth would soon look like the moon's if this did not happen. Many types of fireworks employ metals to generate an intense white light. Incendiary bullets are coated with a thin layer of magnesium which ignites as the bullet speeds through the air and leaves a "trace" of the bullet's trajectory. Flashbulbs contain a very thin wire of zirconium or aluminum which is ignited with electric current and burns in a fraction of a second to produce a flash of light for photography. Many solid-fueled rockets use small particles of aluminum or magnesium to make the flame hotter and stabilize combustion.

All of these examples represent cases where the burning of metal serves some useful purpose. But over the years there have been many times when an accidental metal fire has erupted with disastrous consequences. Usually these accidents involve the use of metal containers for liquid or gaseous oxygen. The Apollo 13 astronauts nearly lost their lives when the metal tank of their oxygen support system ruptured. In 1970, at the Victory Memorial Hospital in Brooklyn, N.Y., a tank truck partially filled with liquid oxygen exploded as it was leaving the parking lot. The driver and a bystander were killed and 30 others injured. There have also been reports of cases where the titanium engine from a high-performance jet aircraft caught fire while being operated on a test stand. So far, there have been no reports of such a fire in an airborne plane.

In an effort to help prevent such accidents, scientists at the National Bureau of Standards have undertaken a study of the basic mechanisms of metal combustion. The team of researchers at the NBS Boulder laboratories, under the direction of Dr. Alan F. Clark, have received support for their research from the Department of Transportation, the National Aeronautics and Space Administration and the Air Force Office of Scientific Research.

NBS metal combustion studies may provide greater safety for the many U.S. workers who each year handle billions of cubic meters of liquid and high-pressure gaseous oxygen contained within metal-walled vessels. Others whose safety may be improved are the tens of millions admitted to hospitals annually where a considerable amount of oxygen in metal containers is present.

Depending upon temperature, pressure, and material, metals in contact with oxygen oxidize either slowly and controllably or violently fast and destructively. Readily ignited contaminates can start metals burning. Applying information on the ignition and the burning of metals should help in suppressing and quenching fires, designing safer oxygen handling equipment, and lowering life and property losses.

*Moulder is a researcher in the NBS Boulder Cryogenics Division, where he is responsible for laser experiments in the metal combustion program.

In one set of experiments designed to duplicate the conditions prevailing in a large-scale metal fire, scientists ignited 100 gram (¼ lb.) specimens of steel in a large steel tank pressurized with pure oxygen and then dropped them onto massive samples of other metals to see if the steel would ignite the other metals or be quenched. These tests were also performed with liquid oxygen present in the tank. For reasons of safety, these experiments were carried on outside in a test area and monitored by closed circuit television.

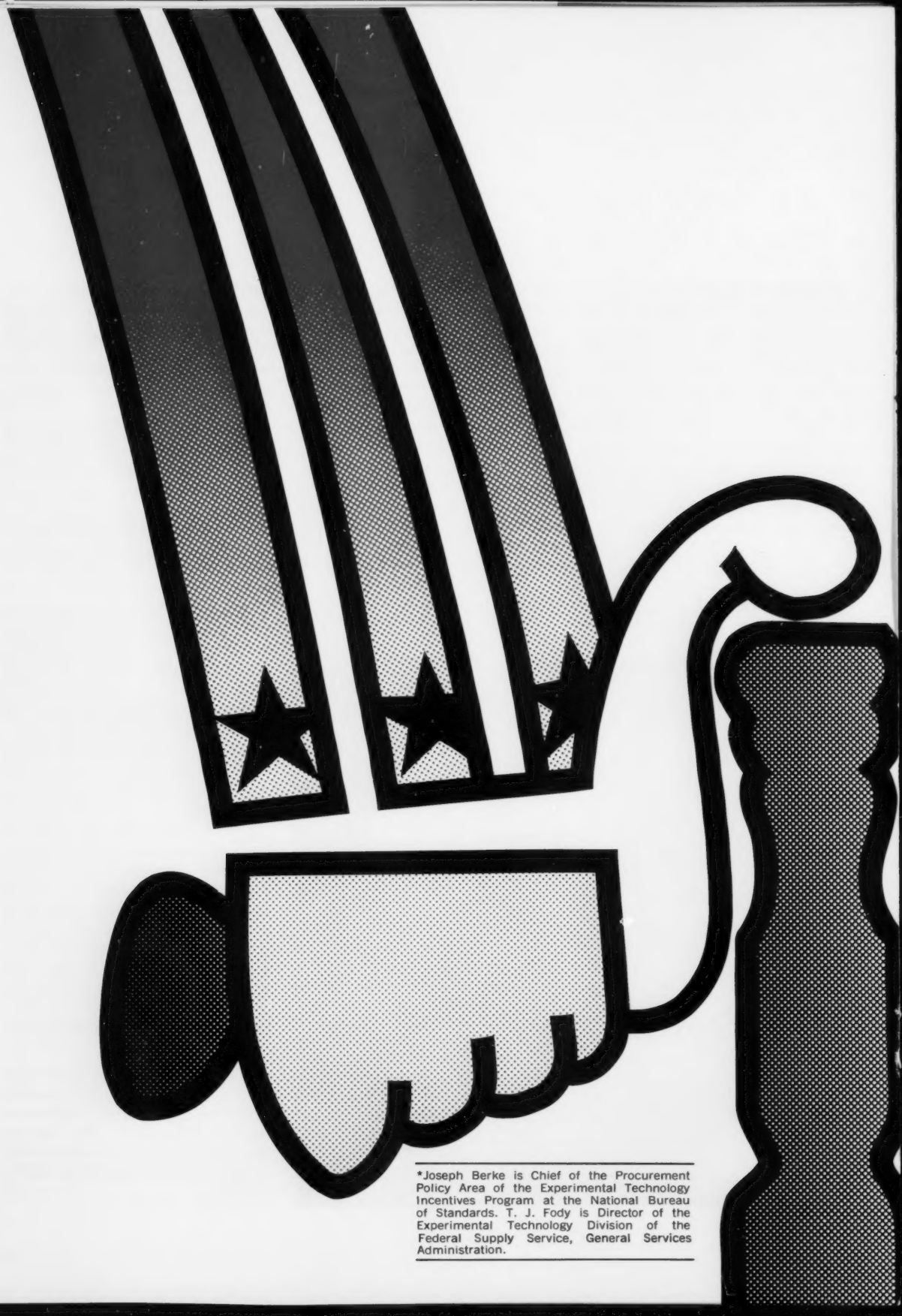
Back in the laboratory under controlled conditions, researchers performed a variety of experiments, using sophisticated instruments to probe the very complex processes that occur as a metal burns. Small pieces of metals like titanium, weighing a few tenths of a gram, were ignited with a one-hundred watt CO_2 laser in a controlled atmosphere. Movies taken at speeds up to 500 frames per second permitted scientists to view the combustion process in slow motion. Temperatures of the metal surface and the flame, which range from 3000-4000 degrees Celsius, were measured with optical pyrometry.

Titanium metal burns spectacularly in a pure oxygen atmosphere during experiments on the causes and processes of metal fires.

Several new techniques were developed by NBS scientists in carrying out this research. In one technique, known as the Hilbert transform method, a low power helium-neon laser was shone through the flame. A series of lens and optical filters converted the normal shadow image of the flame into a "phase contrast" image revealing the temperature gradients in the flame. In another experiment, scientists used a specially-modified electronic weight sensor to weigh metal specimens as they burned, permitting a direct determination of reaction rates.

Using a rapid-scanning spectrometer, Bureau scientists have also mapped the combustion spectra for titanium and a series of titanium alloys from the ultraviolet to the infrared. For a few selected portions of the visible spectrum, they performed time-resolved measurements of the spectra to document the appearance and disappearance of certain species in the flame. Scanning electron microscopy, chemical analysis, and x-ray diffraction were used to identify the combustion products and their location in the interior of the burned-out residue.

This research into the combustion of metals in oxygen will provide theoretical and practical information not previously available. The information will help designers and engineers avoid accidental metal fires in oxygen systems. □



*Joseph Berke is Chief of the Procurement Policy Area of the Experimental Technology Incentives Program at the National Bureau of Standards. T. J. Fody is Director of the Experimental Technology Division of the Federal Supply Service, General Services Administration.

GOVERNMENT PRIMES THE INDUSTRIAL PUMP

*by Joseph Berke and T. J. Fody**

Supply and demand: NBS is testing the Law of the Marketplace in the marketplace itself to see if the Federal Government can improve the products you buy with this oldest of economic laws.

RECENTLY, the Federal Supply Service purchased 7,700 gas and electric water heaters for military housing units. What makes this interesting is that the government, long noted for buying from the lowest bidder, bought the heaters for $110,000 above the lowest bid.

Faced with high utility bills, the government is beginning to place more emphasis on energy efficiency in its purchases and less on low purchase price.

The heating units purchased use 11 percent less energy than the units offered as "low bid," and over their expected 10-year life span they will save the government an estimated $320,000 in energy costs, even considering the initial purchase investment.

The American public will get a bonus in addition to the tax dollars savings. The water heaters were mainly marketed in France, where energy costs are higher than in the United States, but as a result of the FSS contract, the vendor has begun marketing the heaters commercially in this country.

The water heater buy is an experiment, and only one of several such "policy" tests being run by a small office of the National Bureau of Standards called the Experimental Technology Incentives Program (ETIP).

Other experiments include buying window air conditioners, lawn mowers, and gas and electric ranges—all to determine what part government procurement policy can play in improving the Nation's innovativeness and general economic vitality.

The experimental "buys" are the work of ETIP's Procurement Policy Area, one of four ETIP policy areas.

The objective of these and other experiments is to learn if procurement policies—the procedures by which government buys from industry—can be used as an incentive for those industries to innovate, to take a chance on technological change.

Currently the government buys most civilian goods and services at the lowest price available. The "frills" of new or improved technologies are often ignored. This general low bid policy, ETIP believes, tends to restrict the application of new ideas and products that cannot compete with older, cheaper products.

The ETIP objective is to learn if these practices can be changed to realize the basic goal of the procurement program: "To get the best deal or value for the government and the taxpayer." To do this, the program has launched a novel series of "policy experiments."

ETIP believes—and is testing the belief—that one of the best ways to stimulate technological change is to work through the Federal, State, and local Government procurement offices. Although the needs for new or improved technologies begin with a host of user agencies or groups, it is the government purchasing departments that have the responsibility to translate those needs into appropriate specifications, set testing methods, evaluate new products and, in general, determine the "best deal."

The government "clout" to pro-

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vide incentives for technological change rests on the fact that the government is often the largest single buyer of commercial goods. If you add to this Federal market the State and local markets, the incentive to industry to serve the total better is greatly increased.

"Change" here includes not only the introduction of new technologies (better ways of doing things) but also the spread of existing technology—such as the improved water heaters—to existing markets. If the speed of this "technology transfer" can be increased through procurement policy, ETIP wants to know how, and by how much.

Purchasing departments have a number of potential "tools" to accomplish the ETIP objectives. Those being currently tested include performance specifications, life-cycle costing, and value incentive clauses.

Good examples of the use of performance specifications are found in recent Requests for Proposals for hospital equipment to be purchased by the Veterans Administration, another ETIP-sponsored experiment.

Currently design specifications, detailing how the product must be built to be acceptable, are written into the "Request for Proposal" notices the government publishes for interested manufacturers. Those who wish to receive government contracts must offer products that meet these specifications.

Often, these design specifications cover no more than materials to be used, maximum or minimum size, required power supplies, and similar construction details.

Performance specifications, on the other hand, are designed to prompt manufacturers with requirements for specific accomplishments or functional needs.

A device to destroy used hypodermics in a VA hospital, "shall operate quitely, a maximum of 60 dB on the "A" scale, . . . with readings taken 5 feet from the machine." The needles put into the machine, "shall be broken into short lengths," and, "there shall be no 'bounce-back' of glass, metal, or plastic particles to the exterior of the machine."

Performance specs may also specify testing procedures—a bedpan sterilizer must pass a specific sterilization test "by the swab method"—and specify the required level of performance under those tests—the sterilizer must operate at 60 dB or less when measured within 8 feet of the unit.

Life-cycle costing, also called cost-based performance, is buying so as to minimize the total cost of ownership of the product for its expected life, as opposed to minimizing merely the initial purchase price. The water heater experiment is an example of using "LCC."

Individuals already apply LCC to many purchases in order to obtain the best buy for the dollar, usually on a less scientific basis. The decisions to buy one brand over another, to shop in a department store versus a specialty shop, to weigh advantages and disadvantages of warranties and guarantees are some examples of personal life-cycle costing.

An ETIP experiment with the Federal Supply Service in buying window air conditioners applied LCC with a fixed formula:

$$P = X + \frac{Y}{EER}$$

Here X is the initial purchase price, EER is the industry certified Energy Efficiency Ratio—basically an index of how cheap the unit is to run in terms of energy—and Y is a weighting factor to include the anticipated operating cost of the air conditioner in the EER.

P, the adjusted price, includes not only the initial cost, but also the estimated operating cost and efficiency of the air conditioner. Contracts for these air conditioners were awarded to the lowest "P" rather than the lowest "X".

All this experimenting is done remarkably cheaply. The water heater purchasing experiment, which will run for 3 years and involve three separate contract bids and purchases, will cost ETIP about $30,000 to cover extra expenses caused by the novel bidding procedure (including conferences with manufacturers representatives) and extraordinary expenses incurred by the FSS in cooperating with the experiment.

ETIP's LCC formulas often include an innovation in government purchasing, the consideration of subjective value. In the purchase of lawn mowers through the FSS, for example, in addition to the cost of operation the purchasing formula also considered the amount the government was willing to pay for such things as reduced noise. Safety and comfort are other subjective factors that can be considered in awarding contracts.

A third "procurement tool" being tested is the use of so-called "value change incentive clauses" in contract proposals, that allow the contractor to share in any savings to the government that result from an improvement suggested by the contractor. Such suggestions can reduce energy consumption, conserve materials, and so on.

For example, today if a bid is won

on the basis of a price of $50 per unit, and if sometime during the contract period the contractor proposes and demonstrates a changed product that, if he is permitted to substitute, will perform the same functions for only $30 a unit, the total savings on units ordered during the contract period will be divided equally between the contractor and the government.

The situation presently is analagous to buying products at the lowest initial price. Such product improvement suggestions have been generally applied to initial purchase price—a cheaper material used in production, for example, or cheaper packaging.

Future ETIP experiments will examine extending this sort of "profit sharing" over the total ownership cost of the product, just like buying with an LCC formula. Value change incentive clauses, for example, may be written to allow the contractor to share savings in operation costs for the expected life span of the product if he can suggest ways to make it more "energy efficient."

Future splits under ETIP formulas may be 20-80, with the contractor receiving 20 percent of savings as an incentive to reduce total ownership costs. Or a clause might be added to encourage commercialization of a novel technological change where it would not happen naturally.

As might be expected, the results of experiments such as ETIP's are difficult to analyze. ETIP is interested in such questions as how big a government buy is significant to stimulate technological change, how does the private demand for a product affect industry's response to government buys, and how much technological change is the private market willing to accept and pay for.

One question is how much does the government buyer need to know about the existence of a new technology to make use of it. In the first five experiments, ETIP first identified the available technology before a "buy" was announced. This was done to insure that the procurement specifications issued by the government would allow for desired technologies to be applied to the products, and to ensure a high probability of success for these important initial experiments.

The question now becomes, was that really necessary, or could specifications be written without finding out beforehand what industry considers "feasible." Can general speci-

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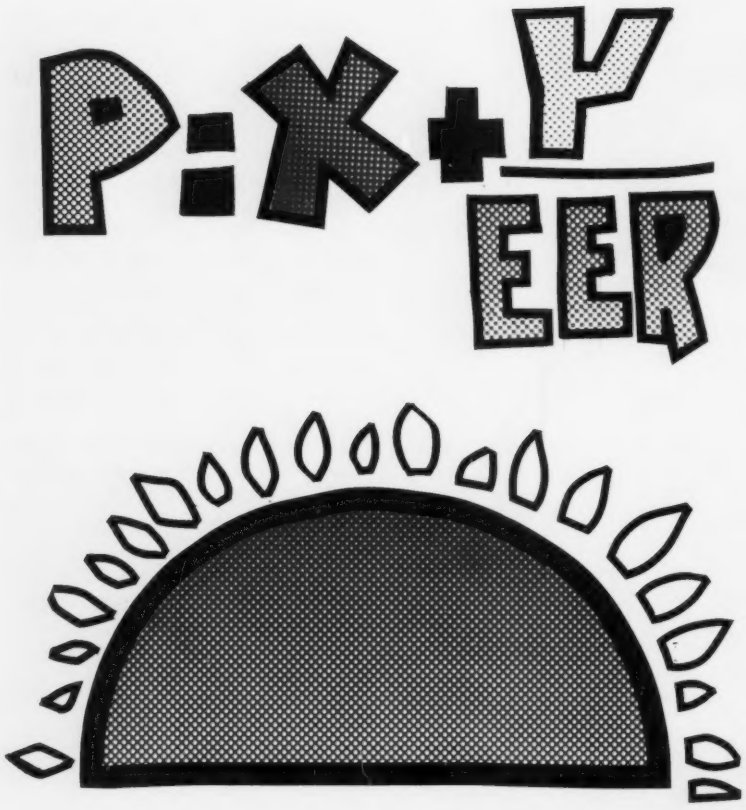


fications be written that will cause a diffusion through the market of existing technology "now on the shelf" or cause the creation of new products to meet the government demand? Future experiments will try to answer this.

By the nature of the subject, ETIP experiments are long. The water heater buy, first completed last February, is expected to run through 3 procurements over 3 years to judge long term effects of the change. The evaluation of these long term effects will include the extent to which other factors might influence the energy conserving technology.

These factors include the energy labeling program at NBS, the President's request for a 20 percent increase in efficiency of appliances by 1980, and other energy conserving technology.

The 3 year time period for these experiments is to provide industry with a sense of security, the knowledge that if money is invested to improve the products offered for sale the government will still be interested when the improvements are made. In the same way, ETIP is seeking approval from the Office of Federal Procurement Policy to let multi-year contracts to provide some continuity to Federal purchasing. Currently, government contracts may only be awarded for a period of 1 year, the time covered by actual appropriations. It is easier to convince manufacturers to invest time and money in improved technologies if they have some assurance that the government will not change its mind after a year and a new budget.

The effect of government buying on the market as a whole will be analyzed several ways, depending on the product in question. Rate of change of technological innovation is measured before and after the government buy to see if there is any appreciable improvement that can, by interviews and study, be directly traced to the government purchase—such as the domestic sale of energy efficient water heaters.

Rates of change can be measured by performance factors, such as change in the product's Energy Efficiency Ratio from year to year, or a change in average noise level from year to year, or by more subjective means, such as evaluations by a panel of experts of the rate of change, good or bad, of a product before and after a government buy.

In addition, the firms responding to a "Request for Proposal" sponsored by ETIP, as well as a sampling of those not responding, are interviewed to determine why they did or didn't bid on a given contract, what effect the government purchase had on their manufacturing or sales policies and similar questions.

In another direction, ETIP is working to enlarge the government's purchasing "clout" through arrangements with State and local organizations, such as the National Association of State Purchasing Officials (NASPO) and National Institute of Government Purchasing (NIGP), to develop consensus procurement specifications. NASPO and NIGP are currently developing uniform specifications for window air conditioners—modeled after the FSS buy—and introducing the use of life-cycle costing on State and local levels.

ETIP is nothing if not ambitious. A comparatively small staff, with a relatively low level of funds is attempting to make changes—important changes—in the ponderous machinery of Federal, State, and local procurement.

ETIP is interested in learning about new products, product standards, testing methods, new approaches to procurement policy, and general innovations in technology and management that apply to ETIP activities. Suggestions and inquiries may be addressed to: Joseph Berke, Chief, Procurement Policy Area, ETIP, National Bureau of Standards, Washington, D.C. 20234. □

What Is ETIP?

Started in 1973, the Experimental Technology Incentives Program at the National Bureau of Standards conducts research in an unusual area—government policy.

The ETIP question is, how can government, just in the way it carries out day-to-day activities, encourage private industry in developing new goods for the marketplace.

Is the spread of new technology hindered by the time it takes for government standards and regulations to be written? One set of ETIP experiments has tested how the time-lag in drafting regulatory standards may be reduced without reducing the quality of the standards. In these experiments, the standards development time was reduced from years to months.

Perhaps the economic regulations that govern such industries as the interstate transportation of food are inadequate and wasteful because the rule-making process is unable to deal with the entire "cost structure" of the industry in one unified system of regulations. An ETIP program with the Federal Railroad Administration is studying that problem, to see if better structured regulations can make food transportation more responsive to the market. Other "experiments" include:

- how industry-wide "technical opportunities" may be identified and exploited
- what steps the government should take to help private inventors and small innovative firms that cannot themselves assume the high cost of research and development
- how new technology developed by the government may best be transferred to the private market.

ETIP have five "policy research" areas: regulatory policy, financial assistance policy, civilian research and development policy, small business policy, and procurement policy.

The typical ETIP experiment involves close cooperation with one of a number of government agencies in key positions, including the General Services Administration (GSA), the Veteran's Administration, the Nuclear Regulatory Commission, and the Environmental Protection Agency.

An experiment is designed and operated within the normal agency structure, such as the purchasing or procurement office, of the "host agency." ETIP pays for extraordinary expenses caused by the project, and arranges for the results to be collected and analyzed.

Programs with the National Institute of Government Purchasing, the National Association of State Purchasing Officials, and several State public utility commissions among others, help ETIP to conduct experiments and judge effects on a State and local level.

The key to the ETIP experiment is to learn about problems in government policy through actual experience—to go out "into the field" and see what works, and what doesn't work, and, if possible, why.

HIGHLIGHTS

Industrial Hygiene SRM's

NBS has announced a new series of Standard Reference Materials (SRM's) for use by industrial hygiene analysts. These SRM's are developed for industrial hygiene analysis and for monitoring workplace atmospheres. The new SRM's are: SRM 2671—Freeze-Dried Urine Certified for Fluorine, SRM 2675—Beryllium on Filter Media, SRM 2676—Metals on Filter Media (Pb, Cd, Zn, Mn). SRM 2671 is issued as a set of two bottles, containing the freeze-dried material for *in situ* reconstitution. Each unit of SRM 2675 and 2676 contains a set of three membrane filters. The cost of each SRM is $80 per unit. They may be ordered from: Office of Standard Reference Materials, Room B311, Chemistry Building, National Bureau of Standards, Washington, D.C. 20234.

Where Does DDT Go?

NBS mathematicians are helping an interagency group on pest management evaluate mathematical models that indirectly measure what happens to DDT as it disperses into the environment. The NBS researchers have focused on a prominent model of the "systems dynamics" type for the global movement of DDT and have added features reflecting photodegradation in the atmosphere and sinking into the ocean depths. The latter mechanism presently seems the principal means for global "disposal" of DDT. The original model traces the pesticide's movement through homogenous worldwide "compartments" of soil, river/lakes, atmosphere, oceans, and fish, considering the different processes of application such as spraying precipitation and evaporation. The revised model appears a suitable starting vehicle for analyzing the fate of DDT and other pesticides.

Hydrogen as a Future Fuel

An NBS study reports that hydrogen is a prime candidate for use as a synthetic fuel in the future. The study, titled "Selected Topics on Hydrogen Fuel," contains an evaluation of the technical and economic feasibility of using hydrogen as a fuel. According to this report, hydrogen is a convenient method of storing energy, and its use reduces air pollution. Considering cost, its use is currently marginal as an auto fuel or as an energy source for the electrical industry. However, it appears attractive as an aircraft and aerospace fuel and could have application in certain integrated gas-electric utilities and in transport of energy from sea-based power plants. Copies of the study, NBS Special Publication 419, may be ordered prepaid for $2.80 by SD Catalog No. C13.10:419 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Code for Electricity Meters

The 6th edition of the widely used "Code for Electricity Metering" is now available from the American National Standards Institute (ANSI). A committee of experts, under the cosponsorship of NBS and the Edison Electric Institute, has completed an extensive revision of the code. This 200-page American National Standard, prepared under ANSI rules, gives performance criteria for new types of watthour meters and associated measuring equipment. It also states acceptable in-service accuracy levels and recommends test methods and test schedules.

Copies of this code may be purchased for $12.75 ($10.20 each for 10 or more) from ANSI, 1430 Broadway, New York, NY 10018.

Time in the Future

The Department of Defense has initiated work on a satellite time program for the future. The program, called Global Positioning System (GPS) will be the major navigation and time dissemination system of the 1980's, featuring 24 clock-carrying satellites and permitting time synchronization to 10 nanoseconds worldwide. NBS is providing technical advice and support for several aspects of the program, including performance specifications and guidance and review of clock development. Future NBS support will include continued consulting and testing as well as laboratory research on limitations in rubidium, cesium, and hydrogen clocks, and validation of test procedures used by GPS contractors in the clock development program.

New Fire Research Project

The Navy has asked NBS to evaluate the fire performance of prospective insulation materials for use in submarines. Phase one of the two-part effort will involve laboratory tests to measure flame spread, ease of ignition, and rate of heat release of candidate materials. During the second part of the project, quarter- and full-scale compartment tests of bulkhead insulation will be conducted. Results of the laboratory and compartment tests will be compared to provide guidance for Navy procurement and to increase our knowledge of the relationship of small and full-scale tests. □

WWV/WWVH User's Guide Published by NBS

"THE Use of NBS High Frequency Broadcasts for Time and Frequency Calibrations" is a new guide which permits users to get the maximum benefit from the National Bureau of Standards' service.

The guide is identified as NBS Technical Note 668 and is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $1.05.

Although newer dissemination techniques are being developed to give even greater stability, accuracy, or reliability, shortwave broadcasts in the 2.5-MHz to 25-MHz band still provide a convenient means of distributing time and frequency information to thousands of users in dozens of different endeavors.

NBS began transmitting standard radio frequencies on a regular schedule from its station WWV (originally in Washington, D.C., now in Fort Collins, Colo.) in 1923, and station WWVH (in Kekaha, Kauai, Hawaii) started operations in 1948. Together the two stations now broadcast accurate time and frequency signals to broad areas of the western hemisphere. (They also provide special services of interest to astronomers, navigators, geodesists and others.)

Noboru Hironaka and Charles Trembath, authors of the guide, place special emphasis on using WWV/WWVH signals to measure time or set clocks with a resolution of ±100 microseconds, or to calibrate frequency to a few parts in 10^{10}. They give specific suggestions on when to make observations, how to optimize reception and measurement conditions, and how to use specific items of equipment such as oscilloscopes, delay circuits, time-interval counters, etc., to make time and frequency measurements or calibrations.

Dimensions and construction details for several types of antennas are given, as are instructions for measuring or computing receiver and propagation delays, great circle distances and incident wave angles. An adjustable time delay generator can be built by the reader from instructions and circuit diagrams provided. □

DOC-GSA Cooperate in Purchase of More Efficient Kitchen Ranges

A recent purchase of energy-efficient kitchen ranges is expected to save the Federal Government approximately $740,000 in net costs over the 12-year expected life of the appliances.

The purchase, made by the Federal Supply Service (FSS) of the General Services Administration, is an experiment of the Experimental Technology Incentives Program (ETIP) administered by the National Bureau of Standards. ETIP and FSS cooperated to make the purchase using the Life Cycle Costing (LCC) concept whereby the total cost of ownership (including lifetime operating costs) is considered in award evaluation as well as the initial bid price.

ETIP and FSS have previously used the LCC concept to purchase energy-efficient water heaters and room air conditioners.

In this most recent purchase, the FSS bought 3,720 electric ranges and 22,200 gas ranges. The largest agency served by FSS is the Department of Defense. The electric ranges purchased are estimated to be 7 percent more energy efficient and will save approximately $120,000 in net costs over the 12-year expected life compared with the lowest bidder. The contracts went to Sunray ($549,000) and General Electric ($178,000).

The gas ranges purchased are estimated to be 7 percent more energy efficient and will save approximately $620,000 in net costs compared with the lowest bidder. Contract winners were Sunray ($1,400,000), Roper ($2,151,000), and Crown ($982,000). □

NBS Makes Computer Network Access Easier

THE National Bureau of Standards has developed a specially programmed minicomputer, the Network Access Machine (NAM), that automatically accesses resources available on computer networks for terminal users. This NBS development is aimed at improving the efficiency and effectiveness of the Federal Government's use of computer networks.

The NAM makes it possible to use one language for accessing different resources within one network or across multiple networks. The same simple user commands or protocols are used to obtain all network services. By automatically generating the necessary interactions that accomplish the user's intended function, the NAM allows the user to be more concerned with what service is required and less concerned with how to obtain it.

The NAM reduces the maze of protocols that exist between a user at his terminal and network-based computer service. Typically, a user must know different protocols to communicate with the network and its host computers, to express his service demands to the computer, and to understand the results or errors from the computer. These user protocols are characteristically incompatible, ill-defined, and machine dependent.

The ability to use one protocol to access all network services can help the network user through this confusion. Since standardization at the higher levels of user-network interaction could discourage competition among network service providers, it seems desirable, instead, to aim at compensating for nonuniformity in interface requirements through network access assistance to the user.

This idea of improving the low level user protocol is not new to the computer industry. Catalogued procedures allow expansions of job control functions so that the inexperienced user can easily perform complicated job steps, and the experienced user can avoid the tedious detail. With this new NBS tool, however, this assistance can be extended beyond a single computer and placed in the interactive computer network environment. In such an environment, the user needs specific programs, data, and systems readily available from different computers without regard for such protocols as:

- host computer selection
- host computer log-in
- host computer service selection
- service initialization
- service exit request
- host computer exit request
- network exit request.

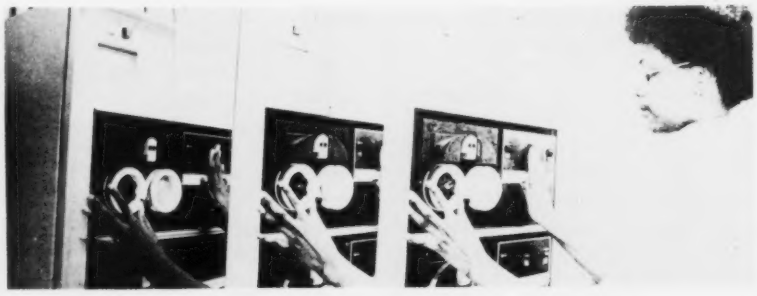
The NAM alleviates this user problem. Complex access procedures, coded and stored as macros on files in the minicomputer, are given simple names by the user. The macros are recalled from the file system by name and expanded by the NAM, thereby producing the appropriate network or host computer dialogue.

At the time of expansion, parameters can be passed to the macro. A possible use for a parameter is to identify to the macro a particular software subsystem. In this way, macros can be written as subroutines—general in scope, but made specific by the parameters passed to them.

The use of simple names for complex access procedures and the ability to pass parameters to macros makes the NAM a flexible aid for any user of remotely accessible computers, especially when the user accesses a variety of different computers.

The prototype NAM is used as a test bed at NBS to determine the utility of the NAM concept and to evaluate the effectiveness of a minicomputer in this application. A long-range goal is to provide Federal agencies with formal guidelines that help them to employ the techniques embodied in the NAM, as well as related techniques, to enhance their use of network-based computer systems and services.

An NBS technical note describing the design and use of the NAM will be available in early 1976. Inquiries about NAM should be addressed to: Robert Rosenthal, Computer Networking Section, Room B212, Technology Bldg., Washington, D.C. 20234. □



Complete Set of FIPS Available from NBS

A complete set of Federal Information Processing Standards (FIPS), including copies of the voluntary industry standards that apply to Federal use, is now available from the National Bureau of Standards at a cost of $46 per set.

The set of three binders includes 39 FIPS and 19 voluntary industry standards.

There are five major categories of standards included in the FIPS series of publications: hardware, software, applications, data, and ADP operations. FIPS are issued by the Bureau for use by Federal departments and agencies in their acquisition and operation of computer equipment and services. FIPS are also cited in Federal Procurement Regulations by the General Services Administration for purchase and lease of computer equipment and associated computer services.

NBS develops FIPS in cooperation with voluntary industry standards activities and through interagency and public advisory committees. After extensive coordination with Federal agencies, State and local governments, and industry, proposed standards are approved by the Secretary of Commerce as authorized by Public Law 89-306 and Executive Order 11717.

The set of FIPS publications, binders, and voluntary standards are available from the Office of ADP Standards Management, Technology Bldg., Room B226, NBS, Washington, D.C. 20234. Checks or money orders should be made out to the "National Bureau of Standards."

The package includes a registration form to be returned to NBS which will be used to notify users of future standards publications as these become available. The price of $46 for the set will vary as new documents are added to the set in the future. □

NBS, EPRI Sign Cooperative Agreement on Energy Measurement Technology

THE National Bureau of Standards and the Electric Power Research Institute (EPRI) have signed a Memorandum of Understanding aimed at helping the U.S. electric utility industry meet the Nation's energy needs in an environmentally and economically acceptable manner.

The agreement establishes the basic guidelines under which measurement technology information on equipment and systems related to the generation, transmission, distribution, and use of electric power can be shared by NBS and EPRI. The agreement was signed by Dr. Ernest Ambler, NBS Acting Director, and Dr. Chauncey Starr, EPRI President.

The NBS-EPRI agreement will enable NBS to do measurement-related research under EPRI or combined NBS-EPRI sponsorship at both the NBS facilities and EPRI experimental project locations, subject to specific agreements between the organizations involved. The agreement also provides for EPRI sponsored personnel to perform research at NBS under the NBS Research Associate Program.

Areas of mutual interest to NBS and EPRI which may be the subject of such research include:

1 Measurement of electrical and electromagnetic quantities.

2 Measurement of physical properties and behavior of materials and devices used or having potential for use in electrical energy production, conversion, control, transmission, and distribution equipment and systems.

3 Measurements required for evaluation and control of the performance, safety, environmental impact, efficiency, reliability, and security of systems and equipment.

4 The application of mathematical and computer sciences and technology to the design, operation, and evaluation of electric power systems.

5 Techniques for industrial, residential, and community energy conservation.

EPRI is a nonprofit organization funded by all sectors of the Nation's electric utility industry-private, public, and cooperative. Its mission is to develop advanced technology to help the industry meet energy needs in an environmentally and economically desirable manner. EPRI currently has 547 research projects now under management or contract negotiation aimed at achieving this mission. Including joint funding, the projects are valued at $380 million.

NBS and EPRI will hold semiannual meetings to review mutual activities. NBS will also provide EPRI with consulting assistance and information. □

NBS Establishes Speakers Bureau for Metric Information

THE National Bureau of Standards has established a nationwide speakers bureau to provide information on the growing use of the metric system of weights and measures.

Dr. Ernest Ambler, NBS Acting Director, noted that more than 125 educators, weights and measures officials, and other knowledgeable persons in 47 states have agreed to act as resources for metric information in their regions. Eventually every geographic region in the country will be covered.

"Many industries in the United States are now in the process of converting to the metric system," Ambler said. "We have established this speakers bureau to meet the need for metric information and to make this resource available to all groups and organizations."

The NBS Acting Director said that Jeffrey V. Odom, chief of the NBS Metric Information Office, will serve as the contact point to link up interested groups with available speakers. Specific arrangements will be worked out between the designated speakers and the group or organization.

Each speaker will receive detailed information and a set of slides from NBS. "This will permit the speakers to offer timely, authoritative information on the metric system and metric conversion," Ambler said.

Groups and organizations desiring information on metric speakers in their State should contact the National Speakers Bureau, Metric Information Office, Room A166, Technology Building, National Bureau of Standards, Washington, D.C. 20234.

A current list of communities with metric speakers follows:

Alabama
- Huntsville
- Montgomery
- Tuscaloosa

Arizona
- Phoenix
- Tucson

Arkansas
- Little Rock

California
- Los Angeles
- Redlands
- Sacramento
- San Jose

Colorado
- Denver

Connecticut
- Hartford
- Willimantic

Delaware
- Dover

District of Columbia

Florida
- Tallahassee

Georgia
- Atlanta

Hawaii
- Honolulu

Idaho
- Boise

Illinois
- Chicago
- Springfield
- Mt. Prospect
- Waukegan

Indiana
- Indianapolis

Iowa
- Ames
- Des Moines

Kansas
- Shawnee Mission
- Topeka

Kentucky
- Frankfort
- Louisville

Louisiana
- Baton Rouge
- Lafayette
- Natchitoches
- Thibodaux

Maine
- Augusta

Maryland
- Hagerstown

Massachusetts
- Boston
- Chestnut Hill
- Amherst
- Springfield
- Salem

Michigan
- E. Lansing
- Lansing
- Pontiac

Minnesota
- N. Mankato
- Minneapolis
- Rochester
- St. Paul

Missouri
- Jefferson City
- St. Louis

Montana
- Billings
- Bozeman

Nebraska
- Beatrice
- Lincoln

Nevada
- Carson City

New Hampshire
- Concord

New Jersey
- Trenton

New Mexico
- Las Cruces
- Santa Fe

New York
- Albany
- Binghamton
- Buffalo
- Cortland
- Little Neck
- Middletown
- Oneonta
- Pearl River
- Potsdam
- Rochester
- Scarsdale
- Syracuse

North Carolina
- Boone
- Raleigh

North Dakota
- Bismarck
- Grand Forks

Ohio
- Akron
- Bowling Green
- Columbus

Oklahoma
- Oklahoma City

Oregon
- Salem

Pennsylvania
- Abington
- Elizabethtown
- Harrisburg
- Indiana

Rhode Island
- Providence

South Carolina
- Charleston
- Clemson
- Myrtle Beach

South Dakota
- Pierre
- Rapid City
- Vermillion

Tennessee
- Nashville
- Oak Ridge

Texas
- College Station

Vermont
- Montpelier

Virginia
- Hampton

Washington
- Olympia
- Pullman
- Spokane

Wisconsin
- La Crosse
- Madison
- Milwaukee
- Stevens Point
- Waukesha

Wyoming
- Cheyenne
- Laramie □

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Publications listed here may be purchased at the listed price from the Superintendent of Documents, U.S. Government P nting Office, Washington, D.C. 20402 (foreign: add 25%). Microfiche copies are available from the National Technical Information Service, Springfield, Va. 22151. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, D.C. 20234.